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BUCKLING MODES OF STRUCTURAL ELEMENTS OF OFF-AXIS FIBER-REINFORCED PLASTICS

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The structures of two types of unidirectional fiber-reinforced composites — with an ELUR-P carbon fiber tape, an XT-118 cold-cure binder with an HSE 180 REM prepreg, and a hot-cure binder — were investigated. The diameters of fibers and fiber bundles (threads) of both the types of composites were measured, and their mutual arrangement was examined both in the semifinished products (in the uncured state) and in the finished composites. The defects characteristic of both the types of binder and manufacturing technique were detected in the cured composites. Based on an analysis of the results obtained, linearized problems on the internal multiscale buckling modes of an individual fiber (with and without account of its interaction with the surrounding matrix) or of a fiber bundle are formulated. In the initial atate, these structural elements of the fibrous composites are in a subcritical (unperturbed) state under the action of shear stresses and tension (compression) in the transverse direction. Such an initial stress state is formed in them in tension and compression tests on flat specimens made of off-axis-reinforced composites with straight fibers. To formulate the problems, the equations derived earlier from a consistent variant of geometrically nonlinear equations of elasticity theory by reducing them to the one-dimensional equations of the theory of straight rods on the basis of a refined Timoshenko shear model with account of tensile-compressive strains in the transverse direction are used. It is shown that, in loading test specimens, a continuous rearrangement of composite structure can occur due to the realization and continuous change of internal buckling modes as the wave-formation parameter varies continuously, which apparently explain the decrease revealed in the tangential shear modulus of the fibrous composites with increasing shear strains.

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